

3. A Transition Period Will Afford the Commission the Opportunity to Undertake Critical Measurements After Normalization of Prices

The Commission does not now possess sufficient data to render decisions regarding appropriate rate levels. The Commission has solicited substantial data from the industry reflecting cable prices as of September 30, 1992. However, the data collected as of the September 30, 1992 target date does not reflect accurately the state of a cable industry subject to rate regulation. It is not likely to have much use in prescribing rate ceilings in the post-1992 Cable Act world. As previously noted, prior to the implementation of the 1992 Act -- and on September 30, 1992 -- cable operators applied varied rate structures and pricing methodologies. There were no industry-wide standards. Thus, data collected as of the target date likely will prove difficult to compare across industry participants.

More important than the "quality" of the data secured in response to the Commission's request is the fact that it reflects the ex ante reality. Congress has changed that reality materially. The 1992 Act requires cable companies to rebalance to rationalize in conformance with the new legal arrangements the rate structures through which they offer service. Since the effective date of the 1992 Act, many cable companies have made substantial alterations in rate structures and pricing practices in anticipation of the Commission's implementation orders. More alterations will occur once those orders are issued. In fact,

this process will involve continual revision as cable operators understand the practical and business effects of the changes mandated by the 1992 Act. The new equilibrium mandated by the 1992 Act is not -- as it could not have been -- reflected in the September 30, 1992 data.⁶⁵ Rather, price normalization can only be accomplished over time. Thus, a clear transition period is required. Only after normalization has occurred can the Commission properly assign specific pricing limitations and, especially, confidently designate egregious pricing thresholds for cable programming services.⁶⁶ In the meantime, the Commission must avoid making permanent rate decisions based on measurements of the industry taken prior to regulation.⁶⁷

Comcast proposes that the Commission implement the regulatory requirements of the 1992 Act in two phases. The first phase, which would be transitional, would begin on April 3, 1993. During Phase One the regulatory limitations would be based on the data collected as of September 30, 1992. For the reasons noted, this interim set of arrangements should be relatively relaxed.

⁶⁵ Because a 180 day review period for cable programming services is mandated by section 623(c)(3), assuming the effective date of the regulations will be April 3, 1993, it will be possible for a complaint to be filed on September 30, 1993, based on the September 30, 1992, data.

⁶⁶ As a preliminary matter, it appears that the 1992 Act will force many cable operators to shift more of the revenue burden to the "expanded basic" or "upper tier" component of cable programming.

⁶⁷ That changing circumstances would make earlier measurements obsolete is not exactly a new insight. "You could not step twice into the same river; for other waters are ever flowing on to you." Heraclitus, On the Universe, 41.

A more permanent set of regulatory standards could be targeted to take effect on January 1, 1995. These would be described well in advance -- the controlling concepts should be set forth in the initial order in this docket. The industry would be accorded an opportunity to make the necessary adjustments -- to "normalize" rates to the new requirements -- after which the necessary rate-related measurements would be taken. This would have the advantage of grounding implementation of the more permanent rules on more precise data that better reflect marketplace realities.

The Commission recently recognized the virtue of an incremental approach in another difficult and controversial context. See Transport Rate Structure and Pricing, CC Dkt 91-213 (rel. Oct. 16, 1992). While the success of the transport change adjustments remains to be seen, the critical point is that there the Commission recognized the practical necessity to permit the local telephone industry twelve months to commence operations pursuant to a new -- but interim -- rate structure. The interim rules will remain in effect for two years, during which time the Commission intends to design permanent arrangements. Overall, then, the Commission established a three year transition for changes in rate structures. As in the Transport Charge decision, the two-stage implementation of regulations here will afford time for proper adjustments and permit the establishment of regulations based on post-normalization data. Furthermore, it will give the Commission an opportunity to see how wholly new

regulatory arrangements are working out to correct unforeseen problems before they become serious. Flash-cut changes are far less forgiving.

Respectfully submitted,

A handwritten signature in cursive script, appearing to read "Brian Conboy", written over a horizontal line.

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TECHNOLOGY CONSIDERATIONS

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Introduction

The technology employed by cable television is evolving very rapidly. The 1984 Cable Act freed the industry and its suppliers from constraints that limited the adoption of new technology and in the process helped to produce major improvements in the quality and quantity of service available to cable subscribers. With the passage of the 1992 Cable Act, one of the principal tasks confronting the Federal Communications Commission is to secure the Congressionally-mandated improvements in industry performance without diminishing or deflecting the pace of technical progress.

The regulation of prices for customer equipment -- as of today principally converters and remotes -- is one area where the risk of unintended consequences is severe. Either a miscategorization of rate-regulated equipment or too severe a set of pricing constraints could have the effect of bringing the government into the design of systems architectures and the selection of new technologies. The risk is a function of the importance of subscriber equipment in the evolution of cable systems and the magnitude of presently foreseeable changes.

This paper addresses the paramount importance of preserving some measure of flexibility to enable the introduction of much greater levels of communications system distributed intelligence in the subscriber's home. The extent of the societal benefits that can be secured from such an evolution is too great to be ignored or inadvertently compromised in the development and implementation of equipment pricing rules.

Overarching Technological Trends

In two areas, technology has been changing and price/performance relationships have improved so rapidly that we are on the threshold of revolutionary changes in available products and

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services. Fiber optics and integrated circuits are transforming all forms of communications and computing for the better. And, happily there is no end in sight regarding further dramatic improvements in these technologies.

While fiber optic technology for communications has been available for some time, its application in cable in any significant way is barely four years old. Its value is increased capacity (whether carrying analog or digital information), improved reliability, increased design and usage flexibility, easy two-way implementation and equal or better cost of implementation and maintenance over the coaxial cable portions of a cable plant it replaces.²

The improvement in integrated circuit technology, first silicon based and then potentially gallium arsenide based has an equal, or maybe even more dramatic impact. This technology makes possible everything from digital video compression to high speed data networks with access directly from subscribers' homes. Experts indicate that the rate of price/performance improvement in the next decade will mirror that of the previous decade - a decade that saw nearly the entire development of the personal computer to where desktop units and portables today challenge the capacity and speed of the largest computers of the early 1980's.

Both of these technologies are fundamental to the cable technology developments highlighted below. In many ways we are only at the beginning. What follows is a discussion of what we can confidently say is either here today or will be available within an 18 month window for initial deployment. That is, there is almost no technological risk to what is described.

Cable Technology Developments

There are four underlying changes occurring in cable technology today: Increased capacity (bandwidth), implementation of digital technology, increased processing power and storage both in the home and at the headend, and interconnection of systems.

Increased Capacity (Bandwidth) - The carrying capacity of a strand of optical fiber is increasing virtually continuously. This includes installed capacity, which can be upgraded by changing the opto-electronics on each end, by using different colors (termed Wave Division Multiplexing (WDM)) and/or with other techniques. Since the introduction of AM transmission of CATV signals on fiber, the capacity of a single fiber has increased from 20 channels over 10km to 80

² In the same time period coaxial cable technology has also nearly doubled in capacity from 550MHz to 1GHz.

channels over 30km, with more improvement in sight in both capacity and reduced cost of opto-electronics. Along with this comes improvement in reliability and signal quality.

However, it is not the capacity of a single fiber which has generated the enormous enhancement in CATV capacity. Rather, it is the relatively inexpensive provisioning of many fibers to individual neighborhoods which has allowed cable systems to be segmented into smaller and smaller geographic groups of homes. By dividing systems into groups of 2,000 homes or less,³ and by engineering these facilities to allow for even smaller groupings as the need develops, it is possible, assuming appropriate source and in-home equipment, to bring not only a variety of new services but the opportunity to supply one or more individual video capable channels to each television or personal computer. Simultaneously, all of the other services more typically broadcast by CATV systems would be available to that television as well as other televisions in the home.⁴ In a every real way, a 100,000 home system is designed as 50 2000 home segments added together.

The second advantage of this segmentation is the reduction of most of the barriers to two-way communication inherent in more traditional cable plant architectures. When the return capacity of a cable system must be shared with all subscribers, there are a number of impediments to effective two-way communication. The most important of these is the amount of return capacity available to any one subscriber, since the needs of all subscribers become additive as the signals make their way to a central headend facility and quickly use up the available capacity. In addition, traditional systems have been susceptible to signals entering the cable (ingress), which introduces interference and thereby limits sophisticated two-way applications. The introduction of fiber, creating a small number of homes per segment with a separate fiber return path, negates the problems of aggregating large numbers of signals. Fiber, which is not susceptible to ingress (or egress), limits the exposure to any signal ingress to a small geographic, and

³ Some future designs are for 500 homes or eventually 200 homes.

⁴ Utilizing this concept, Comcast is already in the planning stages of a trial in Baltimore which would allow a subscriber to select the video product they desire from a menu of choices and see it on demand.

therefore controllable, coaxial cable area.⁵ Therefore, fiber provides an ideal solution to support CATV delivered two-way interactivity in the home.

Digital Technology - Digital technology will be used in three key ways within modern cable systems: digital compression, enhanced signal security and as a transport mechanism for data supporting new and enhanced network access and services.

Digital video compression, made possible by the introduction of low cost, high speed integrated circuits into the home within the cable converter, allows multiple channels of video information to be transmitted using system capacity which heretofore would only support a single channel.

Compression works by eliminating the transmission of redundant information either within a single picture or between two pictures and by sending only what has changed between two pictures. Since the human eye has only a limited ability to see certain aspects of a television picture, some pieces of information may be removed without perceptible degradation of the picture. This further reduces the amount of data needed to reconstruct a seemingly exact duplicate of what was originally transmitted. Presently, it is possible to compress 4, 8 or even 12 video signals into the system capacity normally used for one video channel. The exact amount of compression depends on the source material. Movies need less than television. Rapid motion needs more than relatively inactive content.

The explosion in the potential number of channels delivered actually will change the concept of "a channel". With hundreds or thousands of video signals available to a home, the subscriber will most likely become used to looking for a program using a new electronic program guide rather than tuning to a channel. For example, if subscribers used a remote control to indicate via a menu when they wanted to see a movie and after being presented with a menu of movie choices selected a title, the fact that the actual transmission occurred on channel 357 would be unknown to them. The equipment in the home will transparently tune and decompress the appropriate digital bit stream. In fact in this example, the subscribers never needed to know any channels at all.

⁵ By meeting or exceeding required FCC cumulative leakage index (CLI) standards, a cable system simultaneously reduces the opportunities for signal ingress.

Another example shows a possible use of channel capacity. Assume fiber has been used to segment a cable system into 500 home segments. With compression making a 500 channel system possible, each home could have its own dedicated video channel.

An important benefit of digital transmission is the relative insensitivity that transmission has to electrical noise (the phenomena that introduces "snow" into a television picture). In fact, it is generally easier for a cable system to transmit a digital bit stream which is then reconstructed in the home than it is to send an analog signal which is sent directly to a television set. Paradoxically this means that the signals of a future digital HDTV will be easier to transport than today's analog television.

Once a signal has been digitally encoded, it is fairly easy to use sophisticated techniques to encrypt the data being sent so that only an authorized subscriber will be able to decipher it. Of course, this means that the subscriber's home equipment must be capable of this decipher function and since any code can, with time and sufficient economic provocation, be broken, the home equipment must be capable of changing its method of processing this decipher function.

Until recently, the only method available for upgrading a compromised encryption approach was to replace physical units, as was done in the C-Band satellite business. Every legitimate VideoCipher II home unit was swapped out at an estimated cost of \$50mm. Today, converters are being developed which can use smart cards, or slightly thicker smart modules. These can change the entire security and even the compression system or other system specific processing without the need for replacing the rest of the home unit. One future, exciting implementation of this technology would be to have a smart card supplied by a cable operator inserted into a television set with the basic functionality already in place. This would make the set much more cable ready since the set could be configured to any cable (or non-cable) system that used this technology.

The last use of digital technology is to transport data through a cable system to an end-user terminal. Multiple structures have been proposed for this type of transport. For example, Digital Equipment Corporation has equipment available today which can utilize a small portion of the capacity of a cable system to provide local area network interconnection among users on the entire cable network. IBM has proposed a high speed packet-data network that would be capable of supporting enormous data rates. The digital compression schemes that have been proposed for cable all

have the ability to embed multiple data streams to devices in the home which might include televisions, personal computers, facsimile machines, graphics terminals, electronic games, and telephones. In essence, cable is rapidly creating a high capacity, two-way, digital pathway into the home.

Increased Processing Power and Storage - The extraordinary increase in computer processing power and memory availability has created the opportunity to store video and other content at a centralized location such as a headend and transmit that data either in a broadcast mode, i.e., to all subscribers as in advertising and advertising-supported television, or to an individual subscriber, as in what is termed video on demand. In fact, from a headend or centralized source perspective, the technology available to cable companies is essentially the same as that to telephone companies. In delivery of video on demand, the difference is in the mechanism by which the outside plant is used to deliver the signal to the subscriber's home.

In the near term, a subscriber who wishes to use an on demand service could be temporarily assigned a video channel as described above. However, as the cost of storage in the home decreases, and with the opportunity to provide increased capability through smart cards or smart modules, it will become possible to transfer the compressed video information from the centralized facility to home storage. By utilizing more of the distribution system's capacity, the time for this transfer could be significantly less than the time it would take to view the video product. For example, a movie might be transferred in a few minutes or a portion of a video catalog in only a few seconds. Experiments of this type of technology are already underway. Again, how the capacity is used is transparent to the subscriber. They will only know they have requested a program or service and that it is being delivered to them.

Possibly of even greater value is the very real opportunity to integrate microcomputer technology directly into the cable converter or smart card insert. By transparently turning the cable converter into the equivalent of a personal computer, software providers could find an explosive growth in the size of available markets while users would not face the technical obsolescence of PC purchase. Software could be "downloaded" as a user needed specific functionality. The user could find significantly increased functionality without installing a personal computer.

Interconnection of Systems - Historically, the cable industry has been fragmented based on franchise boundaries. More recently, in an attempt to reduce cost and improve

customer service, headend facilities were eliminated using microwave links. With the introduction of fiber, more headends are being eliminated. However, until very recently, this consolidation and interconnection occurred only within a given Multiple System Operator (MSO).

In the future, this fragmentation will no longer be the case. Three very real business opportunities are driving MSOs to interconnect with each other via fiber. They are advertising sales, pay-per-view/near video on demand and the competitive access business.

As cable advertising channel insertion technology has improved with the introduction of digital techniques, it is possible for cable companies to address the spot advertising market, which heretofore has been foreclosed to cable. This is an \$8 billion market. In order to become a participant in this market, it must be possible to quickly deliver advertising to an entire marketplace or area of dominant influence (ADI). Since most ADI's have a number of cable operators, only by interconnecting all the cable headends is it possible to service this market. We are already seeing the use of fiber for this purpose.

"Video on demand," which today is served by video stores is already a \$12 billion business.⁶ Cable's approach to addressing this opportunity, at least initially, will consist of the delivery of a large number of near video on demand channels. Typically this will involve starting popular movies in 15 to 30 minute intervals. Most likely, these movies will be compressed, broadcast over satellite to cable headends and then distributed through the system. This will require investment in some expensive headend equipment. If one extrapolates further to pure video on demand, the computers and storage required to provide the service will themselves be expensive. In both these cases it makes sense to have a centralized facilities, shared by cable operators in a geographic area through fiber interconnected systems.

The third business is competitive access. This business typically delivers fiber based network services to commercial customers. This is driving more fiber availability through cabled areas and to business parks as well. As this fiber is deployed, the opportunity for even greater system interconnection grows.

⁶ Actually the video store business is larger than \$12B but video on demand would not accrue the significant revenues which occur today because consumers frequently pay for extra days when they do not return tapes on time.

We are seeing the beginning of the regional interconnection of systems. This is expected to continue at a rapid pace. Cable Labs, the cable industry's R&D consortium, has done considerable work in developing redundant regional fiber ring architectures supporting a regional hub concept. If one adds the further interconnection from one regional hub site to another, either directly or through interexchange carriers, the pattern of a complete broadband network to homes, businesses and schools starts to take shape.

Implications

The technological developments in cable leads to three general long term structural implications: 1) cable delivered services will be based on a distributed intelligence architecture; 2) how services are delivered will trade-off bandwidth and cost on a service by service basis; and 3) the equipment in a subscriber's home will be critical to deployment and reducing technical obsolescence.

Distributed Intelligence

A consequence of the improved ability to process information locally has been to distribute the intelligence to act on that information to locations where it is needed. More and more, centralized facilities have taken on the role of storage, aggregation and interconnection with other systems and networks. In fact, that has always been the way CATV, and for that matter broadcast TV, has been delivered. With the relatively low cost of conventional broadcast transmissions or of using coaxial cable to deliver every channel to every home, users could be in complete control by using the distributed "tuner" provided in their television set or within their cable converters. There was no need to communicate to a central facility. The centralized headend acted as an interconnection point for signals delivered via satellite, aggregated off air signals and was the storage and insertion point for video tape pay-per-view or advertising.⁷

As bandwidth becomes less expensive and memory and processing power increase in the home, this distributed architecture will continue to be the architecture of choice for the cable industry. Pieces of capacity will be allocated to different products or services. The device in the home will have the intelligence to make use of the information it receives --

⁷ In essence, the cable system was a "dumb pipe" as described by George Gilder in his recent article "Fibersphere" published in Forbes, ASAP, December 7, 1992.

all at the control of the subscriber.

Of course, not all subscribers will need all the sophistication available. Many subscribers may want to purchase only what today is termed "extended basic" -- the broadcast channels, public educational and governmental channels, and what is typically known as "cable programming," i.e., CNN, ESPN... They will need less in-home intelligence than a user who wants advanced pay-per-view or networked high capacity data services such as might support telecommuting.

This is in stark contrast to typical telephone company solutions which place nearly all of the intelligence in a centralized switching system with much of the control for services requiring communication to and then specific action by that centralized facility.

Bandwidth/Cost Trade-offs

Because of the large capacity CATV pipe between a centralized facility and the home, cable has the opportunity to trade bandwidth for service delivery cost. In the FCC's role of spectrum allocation, it is almost axiomatic that providing more bandwidth to a service will reduce the overall cost of delivery. Of course spectrum is so precious that out of necessity limitations must be placed on the amount of spectrum that is allocated to any one service. Frequently this results in significant activity in finding ways to more efficiently use the spectrum available.⁸ However, doing so is not costless, either in R&D nor in eventual implementation. Compromises are always made.⁹

While cable's bandwidth is not unlimited, there is sufficient capacity to present the opportunity of choosing among systems designs. A cable operator can choose to trade off among bandwidth, complexity and/or cost in a central facility or the home. The simplest example is the delivery of analog television channels. It is technically feasible to compress all channels and provide them in that form to every home, thereby requiring decompression in every home, it is much more likely that a significant number of channels will be

⁸ A primary example would be the implementation of digital cellular over analog where 3 times the conversations can take place over the same cellular channel.

⁹ In digital cellular, reducing the number of bits needed to be transmitted in order to pack more per channel has resulted in the need to have very high speed digital signal processors in every digital mobile telephone.

delivered in their current analog form thereby eliminating the need to install thousands of decompressors. In effect we are trading the bandwidth to deliver those analog signals, which could have the capacity to deliver many times that number of channels if compressed, in order to provide a lower cost infrastructure for delivery of the product. Of course as the cost of decompression equipment changes, that cost equation could also change.

Another example is the carriage of near video on demand, a service where, for example, movies begin every 15 or 30 minutes. Broadcasting a 1 1/2 hour movie every 15 minutes requires 6 channels. The alternative would be to have a switched system which allowed a subscriber actual on demand video. However, this involves establishing a switched system for the entire subscriber base. As described earlier, this is an option for cable. However, it is expected that the cost to deliver in broadcast mode will be significantly less than in the switched mode. This is particularly true if compression is being used. In that case, the total bandwidth needed for the six movie "channels" is less than one of today's video channels.

The opportunity to download video content or software at real time speeds or via high speed burst as described above is yet another example of a bandwidth trade-off. The flexibility to do these trade-offs will become even more important as interactive and multimedia applications begin to take shape.

Critical Nature of Home Equipment

It should now be clear that any system, the design of which is predicated on high bandwidth and distributed intelligence, relies on the ability of the home equipment in the final delivery of products and services in a way that is user friendly, acceptable and at realistic levels of cost. More importantly, as technology continues its rapid change and improvement, obsolescence of the home equipment becomes a critical concern. Today, obsolescence is handled by the replacement of cable-related in home equipment with equipment of new, more advanced capability. However, with digital compression and many enhanced new services, that cost could be very great. Further, since much of the intelligence of the new convertors can be transparent to the user, the opportunity exists to introduce new technologies into the home much more rapidly and in an integrated fashion.

The good news is that technology is giving us an answer whereby at least some of the cost of the home device need not be replicated time after time. On the other hand, the need for such equipment to effectively interface with televisions,

both today's and HDTV, personal computers and other devices yet to be determined adds enormously to the complexity.

Given the extraordinary advantages associated with providing broadband, interconnected capabilities to the home and the natural course of the development of the cable television business in that direction in a relatively near time frame¹⁰ flexibility in dealing with the "distributed intelligence" in the home will be of paramount importance.

¹⁰ It is likely that a majority of systems will use these advanced architectures and technologies by the end of the decade.

Biography

Mark A. Coblitz is Vice President Strategic Planning for Comcast Corporation. His primary responsibility is the development of new business opportunities particularly from emerging technologies.

Comcast is a leading U.S. Cable Television operator with ownership interests in systems serving more than 2.8 million subscribers. Comcast also provides cellular telephone service to communities with a population of more than 7 million. In addition, Comcast also has franchises for approximately 1.0 million homes in the United Kingdom for the provision of both cable television and telephony and has a majority interest in Eastern TeleLogic, a fiber optic network provider of business telephony service in Philadelphia.

Prior to joining Comcast in 1989, Mr. Coblitz was a consultant with Strategic Planning Associates, Washington, D.C. where he consulted on strategic issues in industries as varied as aerospace, telecommunications, financial services and textiles. He was a Captain in the United States Air Force serving at the Pentagon.

Mr. Coblitz is a member of the Partners Committee of PrimeStar Partners, a direct broadcast satellite venture, a director of Eastern TeleLogic, a member of the Investors Committee of Faroudja Research Enterprises, a developer of advanced television technology, the chairman of Cable Television Laboratories Technical Advisory Subcommittee on Personal Communication Services and is a director of the British American Chamber of Commerce of Philadelphia.

He holds a B.S. in Management Science with honors from Case Institute of Technology and is a distinguished graduate of Carnegie Mellon's Graduate School of Industrial Administration.